מדינת ישראל
STATE OF ISRAEL

M try of Justice
tent Office

משרד המשפטים
לשכת הפטנטים

hi o certify that annexed
s a true copy of the
ts as originally
with the patent
of which
specified on the
nex.

זאת לתעודה כי רצופים
בזה העתקים נכונים של
המסמכים שהופקדו
לכתחילה עם הבקשה
לפטנט לפי הפרטים
הרשומים בעמוד הראשון
של הנספח.

This 25-12-2000 היום

רשם הפטנטים
Commissioner of Patents

נתאשר
Certified

לשימוש הלשכה
For Office Use

מספר: Number:	105,764/2
תאריך: Date	20 MAY 1993
הוקדם/נדחה Ante/Post-dated	

חוק הפטנטים, תשכ"ז—1967
PATENT LAW, 5727 - 1967

בקשה לפטנט
Application for Patent

C:16762

אני, (שם המבקש, מענו ולגבי גוף מאוגד - מקום התאגדותו)
I (Name and address of applicant, and in case of body corporate-place of incorporation)

ORAD HI -TEC SYSTEMS LTD.
P.O. Box 695,
Raanana 43106

אורעד מערכות הי-טק בע"מ
ת.ד. 695
רעננה 43106

AND

ADVANCED TECHNOLOGY INCUBATOR INC.
31275 NORTHWESTERN HIGHWAY,
FARMINGTON HILLS, MICHIGAN 48334, USA

-ו-

INVENTORS: MICHAEL TAMIR
AVI SHARIR

הממציאים: מיכאל תמיר
אבי שריר

שמה הוא ..... בעל אמצאה מכח
of an invention the title of which is ..... Owner, by virtue of

(בעברית) (Hebrew): מערכת ושיטה אלקטרונית להעברת נתונים

(באנגלית) (English): ELECTRONIC DATA TRANSMISSION AND DISPLAY SYSTEM AND METHOD

hereby apply for a patent to be granted to me in respect thereof. מבקש בזאת כי ינתן לי עליה פטנט

• בקשת חלוקה — Application of Division	• בקשת פטנט מוסף — Application for Patent Addition	• דרישת דין קדימה Priority Claim		
מבקשת פטנט from Application	• לבקשה/לפטנט to Patent/Appl.	מספר/סימן Number/Mark	תאריך Date	מדינת האגוד Convention Country
No. ..... מס'	No. ..... מס'			
dated ..... מיום	dated ..... מיום			

• ישוי כח: כללי / מיוחד — רצוף בזה / עוד יוגש
P.O.A.: general/individual-attached/to be filed later-

filed in case ..... הוגש בענין

המען למסירת מסמכים בישראל
Address for Service in Israel

Sanford T. Colb & Co. סנפורד ט. קולב
P.O.B. 2273 ת.ד. 2273
Rehovot 76 122 רחובות 76122

חתימת המבקש
Signature of Applicant

For the Applicant,

Sanford T. Colb & Co.
C: 16762

היום 20 בחודש MAY שנת 1993
This ..... of ..... of the year

לשימוש הלשכה
For Office Use

תאריך הפרסום 20.11.97
תאריך המתן

מערכת ושיטה אלקטרונית להעברת ולהצגת נתונים

ELECTRONIC DATA TRANSMISSION AND DISPLAY SYSTEM AND METHOD

ORAD HI -TEC SYSTEMS LTD.

Inventors: Michael Tamir
and Avi Sharir

C:16762

אורעד מערכות הי-טק בע"מ

הממציאים: מיכאל תמיר
אבי שריר

ELECTRONIC DATA TRANSMISSION AND DISPLAY SYSTEM AND METHOD

The present invention relates to an electronic data transmission and display system suitable for use in transmitting data to display devices such as electronic shelf labels as in supermarkets, advertising or information displays on store shelves, walls or shopping carts. The system of this invention can in effect be used anywhere requiring transmission of frequently changing data to different locations remote from a central base station such as in a bulletin paging system or for inventory control in warehousing, especially when the end units are mobile or when they cannot interface the electricity network.

Several electronic systems have been proposed in the past for displaying prices and change of prices in supermarkets and large department stores. The problem that these systems intend to solve is the high cost in labor and time that is required to change the prices displayed near the goods on a shelf. This is particularly true in recent years when prices fluctuate so frequently and in the case of businesses having thousands of items on display for sale, such as supermarkets.

U.S. Patent 4,002,886 discloses such a system wherein data is transmitted to price display units from a central computer via a hard-wired data link. US 4,521,677 discloses a system using a cable or wireless communication link between the computer and the electronic display. Other systems use radio signals to up-date information in electronic shelf displays. These systems overcome the problem of connecting wires to all the thousands of display units in a store (which makes them immobile and clutters the area), but suffer from other problems which make it impractical to implement. For one thing, the displays are operated with batteries having a short lifetime requiring replacement of thousands of batteries from time to time. Moreover, the displays require antennas for receiving the radio transmission, and reception can often be distorted by other

electronic devices nearby. In addition, radio transmission requires approval from the authorities, which is inconvenient and time consuming. The cost of such a radio communication system makes it impractical for use in large retail stores.

Recently, two patents appeared which propose the transmission of data from a central computer to the electronic display units via modulation of the lighting system in the building. WO 90/13067 discloses operating such a system with a light modulator connected in the electric supply to the electric lighting so as to modulate the supply with address and data information signals which are received by LCD modules provided with solar cells to supply operating power. GB 2 244 359 discloses a similar system and suggests using Bar code information of the products to generate an address code which is programed into the display unit.

The systems and method disclosed by these last two patents are certainly an improvement over the earlier systems. However they still have certain drawbacks which prevented them from becoming commercially acceptable. The transmission bandwidth afforded by both methods is very small (less than 10 - 50 bits per second) and is insufficient to allow real-time updating of a large number of displays. Furthermore, the modulation of the store's light as disclosed, is visible to the eye and can seriously annoy the shoppers. Moreover, the modulation of the amplitude as disclosed is not reliable and causes many false alarms. The LCD displays consume energy continuously and lead to frequent replacement of batteries or solar cell power feeding mechanisms. Yet another drawback is the fact that the lights must be turned on in order to pass on the transmission. Thus if a business is closed for the week-end or holidays, no updating of displays can be done, and such updating will have to take place during business hours which may take many hours, particularly in large retail stores with thousands of products. If such a system could be made to operate more quickly in real-time, it could

also be used to advertise instantaneous promotional sales and thus serve as an electronic "coupon".

It is the object of this invention to provide a system and method to transmit wirelessly messages from a central computer to a multiplicity of display modules in a store, warehouse or other building, in real-time. these displays may be mobile as when they are mounted on shopping carts.

A further object of this invention to provide such a system and method that operates using the available building's lighting system.

Another object of the invention is to utilize the above system and method by modulating the lights in a manner undetectable to the human eye.

A still further object of the invention is to provide such a system which can operate with the lights turned off, such as at night or on week ends and holidays enabling the updating of thousands of prices when the premises are not in use.

Yet another object of the invention is to provide such a system and method using a transmission bandwidth capable of transmitting at least 50 characters per second, which is equivalent to a transmission bandwidth larger than 300 bits per second.

An additional object of the invention is to provide a system and method further including an additional module installed in each room of the building, for receiving and decoding the transmitted message and indicate to the main computer when a given message has not been communicated correctly to the location where the particular display is supposed to be, thus serving as an error correction channel.

Still another object of the invention is to provide a system and method for sales promotion and advertising.

It is also an object of the invention to provide the above system and method using display units not having batteries incorporated therein, or with batteries that must be replaced only after 2-3 years.

In accordance with this invention there is provided an electronic data transmission and display system comprising :

a central computer;

a current/ voltage network modulator interfaced to a mains network;

a modulation controller interfaced to the central computer and to the network modulator; and

a plurality of display modules having means for receiving and decoding modulated signals from the mains network;

wherein said modulator includes means for modulating the initialization time of each half cycle of the 50/60 Hz mains network.

The modulation controller may be interfaced to or installed in the computer.

In one embodiment of the invention the system uses the lighting system to transmit information to the display modules. Each data packet consists of an address and a message which may be an update of the product price or a product advertising slogan, or promotional sale announcement or information data.

The system operates by using the communication link and

modulation of the initialization time of each "half cycle" of the 50/60 Hz mains signal. The information is thus contained in the rise time delay of the signal in each 100 or 120 Hz "half cycle" of the mains network. The temporal behavior of the fluorescent light shows a similar pattern and the same information contained in the current/voltage rise-time delay is translated into a corresponding delay in the light ignition time in each half cycle. A small portion of the time modulated emitted fluorescent light is collected by a photosensitive receiver contained in each display module. This signal is then decoded with suitable electronic circuitry and the information is displayed. By using a varying time gate in the receiver, a band-width of at least 300 Hz may be obtained which is more than one order of magnitude larger than that of the prior art.

We have found that the average intensity degradation caused by delay periods larger than about 100 μsec are detected by the human eye and thus can disturb and annoy shoppers. The present invention avoids this by using a special network modulating technique wherein the mains energy incorporated in the delay period is stored by charging a capacitor which is discharged after the light ignition so that each half cycle contains the same amount of energy in spite of its different duration. The method thus makes use of relatively long delay periods without disturbing or being detected by the eye.

In a preferred embodiment of the invention each of the display modules uses the store's light energy as its energy source by using a solar cell to charge a rechargeable battery. In another embodiment the modules use regular batteries that have to be replaced only after 2-3 years. The display module, according to a preferred embodiment of this invention, is designed to consume a minimal amount of power. Thus the display module comprises a) a front-lit liquid crystal, preferably of the Polymer Stabilized Cholesteric Texture (PSCT) kind which can operate in the reflective mode with high contrast. The PSCT based

display has a gray scale memory i.e. two stable states at zero field, to assure that the power is consumed only when the particular display is changed and b) electronic circuitry using an intrmittent mode of operation. The use of a PSCT display leads to an order of magnitude of saving of the average power consumption. The intermittent mode of operation of the circuitry enables significant energy saving since the receiver is activated and consumes power only for short periods, while it is being called up via a wake up signal. At all other times the PSCT display does not consume any energy. The wake up signal is transmitted repeatedly via the lights communication channel and is sensed by the receiver during one of its activation pulses.
After sensing the wake up signal the receiver is activated for a continuous period until an end-of-message code is received.

In another preferred embodiment of the invention, the modulated signal from the mains network may be received via a simple antenna that receives a modulated electromagnetic mains network pulse. With this embodiment it becomes possible to operate the transmission link in the dark, making it possible to update data, such as prices, during the night or on weekends. In this embodiment the light detection system is bypassed.

The system preferably comprises the following units:

a) A controller board inserted into the central computer interfaced either by cable or wirelessly to the modulator unit. A special system control code is loaded into the central computer as well. This code interprets a given message (sent by an operator) comprising an address and data into time modulation instructions to the modulator unit;

b) A modulator unit, which is preferably installed in the mains control box, to modulate the mains network current. The modulator includes a capacitor circuit to equalize the energy contained in a "modified" (delayed ignition time) half wave with that of the

unmodified wave;

c) A plurality of display modules for mounting on product shelves or on shopping carts. Each display module contains a photodetector to collect fluorescent light, or an antenna to detect electromagnetic pulses originating from the mains network modulation, or both (with suitable electronic and mechanical design, a photodiode may also serve as the radio antenna), an LCD display, a battery which may be rechargeable, and electronic circuitry, including a micro-controller, to decode and interpret the received modulated signal. In a preferred embodiment, the display module also contains solar cells which feed power to a rechargeable battery; and

d) checking devices, mounted in each room or area of the building, to check the quality of the transmitted messages. The checking devices include a photodiode and decoding circuitry similar to that used in the receiver and are preferably connected to the electricity network and operate continuously. These devices check only if the message has been correctly interpreted into light modulation patterns in the vicinity of the receiver to whom the message has been addressed and thus only gives a partial communication check.

The above objects and advantages of the invention will become more readily apparent from the following description with reference to the accompanying drawings in which:

Fig. 1 is a block diagram of a system in accordance with a preferred embodiment of the invention;

Fig. 2 illustrates the wavefronts of the unmodulated and modulated current/voltage signals used in the embodiment of Fig.1;

Fig. 3 is a simplified circuit schematic of modulator design in accordance with one preferred embodiment of the invention; and

Fig. 4 is a block diagram of a display module in accordance with a preferred embodiment of the invention.

The invention will now be described for a system installed in a store such as a supermarket. The system makes use of the fluorescent or other lights in the store as the communication link between the store's computer and the display units. These are placed on the shelves next to the products on display. Alternatively the display units may be advertising displays which can be placed anywhere in the store, for example, on shopping carts. Such a system is illustrated in block diagram form in Fig. 1 and comprises a computer 12 in which has been installed a controller board 14, a modulator 16 for modulating the lights 20 via a mains network 22, and display units 24 which receive modulated coded signals and display a decoded message. A communication quality-checking device may be installed within the building to assure that the instructions to the various displays are being properly converted into light modulation patterns.

The intensity of the fluorescent light is comprised of two contributions, a DC component resulting from the lamp "memory", and a periodic AC component which follows the mains current/voltage cycling and shows a $\sin^2$ time dependence as illustrated in Fig. 2, which shows typical temporal patterns of signals wherein the solid line represents the unmodulated signal and the broken line the modulated (late ignition) signal in accordance with a preferred embodiment of the invention. The mains network current/voltage is shown in curve (a), the light intensity in (b), the temporal derivative of the light intensity in (c) and the polarity of the temporal derivative in (d). A differential circuit in each receiver module extracts the temporal derivative of the collected fluorescent light. The time interval at which a polarity change of this derivative occurs is

interval at which a polarity change of this derivative occurs is then measured and used to decode the information bits.

Power switching is achieved by means of a triac 34 in the modulator unit shown in Fig. 3. The triac 34 conducts current in both directions when triggered by a signal applied to its gate "G." Current conduction ceases when the current falls to zero. This means that in order to conduct an AC signal a trigger pulse should be applied at the beginning of each half cycle. A time delay in this trigger pulse can carry information. The afforded number of distinguishable time delays (and consequent number of bits) may exceed few tens in a stable network. This will also determine the bandwidth of the communication link. For just one distinguishable time delay a 50-100Hz bandwidth is expected. For 10 intervals a bandwidth 500-1000Hz results. Such a wide bandwidth cannot be achieved with other light modulating systems.

One factor potentially limiting the maximal communication bandwidth is the fall in average light intensity during broadcasting sessions. We have discovered that an average ignition delay time larger than 100 μsec is noticed by the human eye and may annoy shoppers in the store. To overcome this problem this invention uses an energy equalizing procedure as illustrated in Fig. 3 so that all half cycles are energy equal and no disturbance is observed.

Referring now to Fig.3, there is shown a circuit block diagram of a modulator 30, for equalizing the energy of a "delayed" half cycle as compared with the normal cycle, wherein 32 is the mains power source and can be either 220V/50HZ or 110V/60HZ. A triac 34 transmits AC current through a group of fluorescent lights 36 when a trigger signal is sent to a gate "G" from a controller 37. Communication controller 37 receives digital signals from the computer and transforms them into trigger signals applied to the triac gate. This module controls

then measured and used to decode the information bits.

Power switching is achieved by means of a triac 34 in the modulator unit shown in Fig. 3. The triac 34 conducts current in both directions when triggered by a signal applied to its gate G. Current conduction ceases when the current falls to zero. This means that in order to conduct an AC signal a trigger pulse should be applied at the beginning of each half cycle. A time delay in this trigger pulse can carry information. The afforded number of distinguishable time delays (and consequent number of bits) may exceed few tens in a stable network. This will also determine the bandwidth of the communication link. For just one distinguishable time delay a 50-100Hz bandwidth is expected. For 10 intervals a bandwidth 500-1000Hz results. Such a wide bandwidth cannot be achieved with other light modulating systems.

One factor potentially limiting the maximal communication bandwidth is the fall in average light intensity during broadcasting sessions. We have discovered that an average ignition delay time larger than 100 μsec is noticed by the human eye and may annoy shoppers in the store. To overcome this problem this invention uses an energy equalizing procedure as illustrated in Fig. 3 so that all half cycles are energy equal and no disturbance is observed.

Referring now to Fig.3, there is shown a circuit block diagram of a modulator 30, for equalizing the energy of a "delayed" half cycle as compared with the normal cycle, wherein 32 is the mains power source and can be either 220V/50HZ or 110V/60HZ. A triac 34 transmits AC current through a group of fluorescent lights 36 when a trigger signal is sent to a gate "G" from a controller 37. Communication controller 37 receives digital signals from the computer and transforms them into trigger signals applied to the triac gate. This module controls the status of the two current switches 38 and 39. When these

switches are in the "1" position energy is charged in the capacitor 35 and no current flows through the lights 36. When the controller 37 triggers the triac 34, switches 38 and 39 are simultaneously switched to the "2" position and the capacitor energy is discharged into the light circuit. The capacitor circuit accumulates the network charge when no current flows through the circuit so that the energy in a modified half cycle is equal to a normal one.

The modulator is designed to enable an unlimited number of module units to be connected with one computer and is preferably small in dimension and can be about 100mm X 140mm X 30mm, or less.

The modulator unit is generally installed near or inside the store light's control box and is connected to the controller via a communication link (cable or wireless).

Fig. 4 illustrates a block diagram of a display module in accordance with a preferred embodiment of the invention. The fluorescent light rays 50 are collected by photodiode 52 (or a phototransistor) and are transformed into electrical signals. These are AC coupled via capacitor 54 to an amplifier 56. AC coupling blocks the DC component present because of the fluorescent "memory" or other illumination sources. The AC component is amplified by amplifier 56 and fed into a differentiation circuit 58 which produces as its output the derivative of the received signal. This derivative is compared to zero in a comparator circuit 59 which outputs a logic level representing the polarity of the derivative. A microprocessor (such as MOTOROLA MC68HC705J2) embedded in the display module samples the signal from comparator 59 and analyses the transitions as a function of time, thus identifying the broadcasted digits.

Alternatively, the communication link is implemented by detecting the electromagnetic pulse originating from the mains network modulation. This is accomplished by using a dedicated antenna 51 in each receiver unit or utilizing the photodiode itself as a radio wave receiver. The decoding circuit is common for both receiving methods as shown in Fig. 4. The antenna receives the electromagnetic pulse originating from the mains modulation. A battery 55, which may be chargeable by solar cells, supplies power to the unit via a power control circuit.

The power switching method has outstanding advantages over other modulation methods as follows:

a) The modulation is more efficient and cheaper and does not require cooling.

b) The communication link is much more immune to background noise mechanisms like natural or other artificial illumination sources or to loading changes in the mains network and to the fluorescent natural intensity degradation. The transmission false alarm rate is thus much lower.

One important feature of the invention is the low power consumption of the display modules.

The electronic price labels proposed to date suffer from one or more of the following deficiencies.

- The LCD's are either back-lit or they have poor contrast. Back-lighting is power consuming and thus cancels many of the advantages of these LCD's, particularly their low drive power requirements. The LCD's currently used would be unacceptable in store environments without back-lighting.

- Moreover, even without back-lighting, the currently used

LCD's consume too much power to be useful as stand-alone display modules and require solar cells with the associated circuitry to be usable which make the modules more expensive. Another disadvantage of the conventional LCD's is the fact that solar cell based units cannot be shut down (without lighting) for more than about 24 hours or the information stored in the unit will be erased. To reload the data in all the store modules can take hours.

In accordance with this invention it is therefore proposed to preferably use Polymer Stabilized Cholesteric texture (PSCT) displays. These have been developed by Kent State University and ATI. These displays have the ability of maintaining an image on the display without any electrical input. Power is consumed only during the addressing periods. The average power consumption of the PSCT display is orders of magnitude smaller than the competitive displays.

To achieve a corresponding decrease in the power consumption of the other electronic circuits comprising the display module we use an intermittent (rather than continuous) mode of operation- the electronic circuitry is periodically activated for only short periods of time (typically 20 milliseconds) and its average power consumption is thus reduced. This method thus necessitates repetitive broadcasting (via the fluorescent lights) of "wake up" signals before the message starts. These "wake up" signals are repetitively transmitted at such a high frequency that at least one signal is captured by the display unit during its "on" period. This wakes up the display unit to be continuously activated to receive the message directed to it. The switch back to a sleeping mode occurs at the end of the message or when the display recognizes that the message is addressed to another unit. This power design permits the use of small inexpensive batteries in each display module. Such batteries having a life expectancy of 2-3 years.

Another advantage of the PSCT module is that it can operate in the reflective mode without backlighting and use the store's lights to provide a very high contrast image (1:8), which is quite significant when dealing with point of sale advertising.

It will be appreciated that the system and method of this invention can make use of product bar codes in a manner similar to that disclosed in the prior art, whereby each display unit has a mode of operation displaying a product bar code and this bar code will be ascribed by the central computer of a store to a product code on a shelf.

The system described above can also be applied in large buildings, hospitals and manufacturing plants to page people via display modules. It may also be used for inventory control in warehousing.

It will be appreciated by skilled persons in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims which follow.

CLAIMS

1. Electronic data transmission and display system comprising :

a central computer;

a current/voltage network modulator interfaced to a mains network and adapted to modulate the mains current and voltage;

a modulation controller interfaced to the central computer and to the network modulator; and

a plurality of display modules having means for receiving and decoding the modulation of the mains current and voltage;

wherein said modulator includes means for modulating the initialization time of each half period of the mains current and voltage.

2. A system as in claim 1 wherein said modulation controller is incorporated in the central computer.

3. A system as in claims 1 and 2 wherein the modulation is transmitted to the display modules via a lighting system.

4. A system as in claims 1-2 wherein the modulated signals from the mains network are transmitted to the display units via electromagnetic disturbances originating from the mains modulation.

5. A system as in claims 1-4 wherein the modulator

includes a capacitor circuit to equalize the energy of a modified wave with that of an unmodified wave.

6. A system as in claims 1-5 wherein the modulator is installed in the lighting control box.

7. A system as in claims 1-6 wherein the display unit comprises a light detector to receive light signals, a liquid crystal (LC) display, a battery for powering the display module, and electronic circuitry including a micro-controller to decode and interpret the received message and to control the LC display.

8. A system as in claim 7 wherein the display module also includes solar cells to convert solar energy to electrical energy.

9. A system as in claims 1-8 also comprising means for checking the quality of transmitted messages, including a light detector and decoding circuitry.

10. A system as in any of the previous claims wherein the display is a Polymer Stabilized Cholesteric Texture (PSCT) displays.

11. A method of transmitting electronic data wirelessly to a plurality of display modules from a remote central control unit, said display modules being provided with means for receiving and decoding signals carried by a mains network, comprising the steps of modulating the initialization time of each half cycle of the mains current and voltage signal.

12. A method as in claim 11 including the step of transmitting the signals to the display modules via a lighting system.

13. A method as in claim 12 including the step of transmitting the signals from the mains network to the display modules via induced electromagnetic pulses originating from the mains network modulation.

14. A method as in claims 11-13 including the step of equalizing the energy of a modified wave with that of an unmodified wave.

15. A method as in claims 12-14 using a system of claims 6-10.

16. A system as in claims 1-10 operated to provide price labels and update them in retail stores using the store lights.

17. A system as in claims 1-10 operated to provide price labels and update them in retail stores in the absence of light.

18. A system as in claims 1-10 operated to display advertisements.

19. A system as in claims 1-10 used in operating mobile display modules.

20. A system as in claims 1-10 used for paging people in a building such as a hospital or manufacturing plant.

21. A system as in claims 1-10 used for inventory in warehousing.

For the Applicant,

SANFORD T. COLB & CO.
C:16762

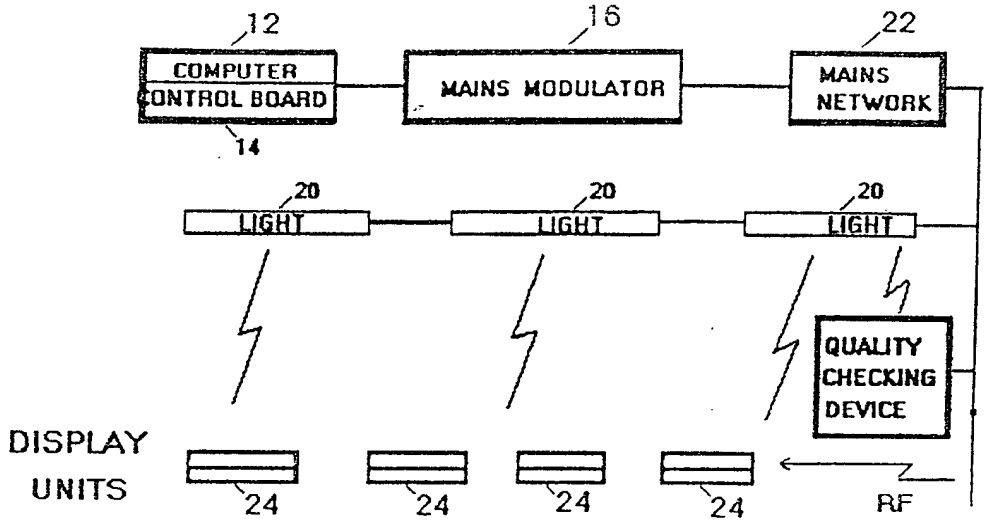

FIGURE 1

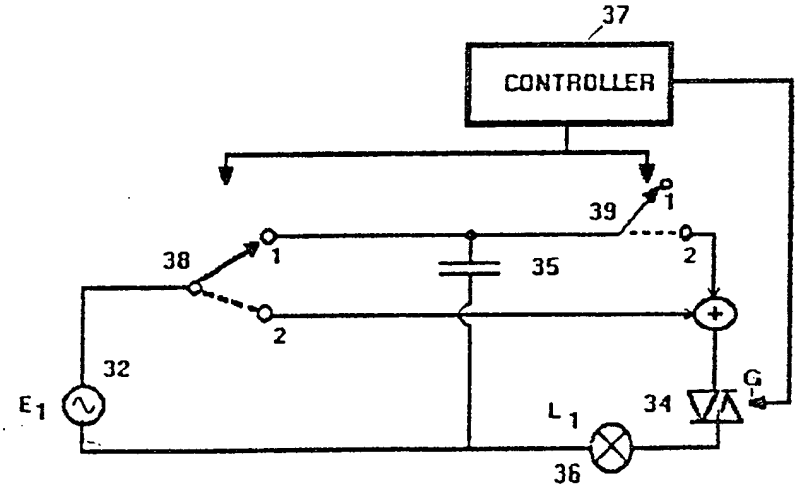

FIGURE 3

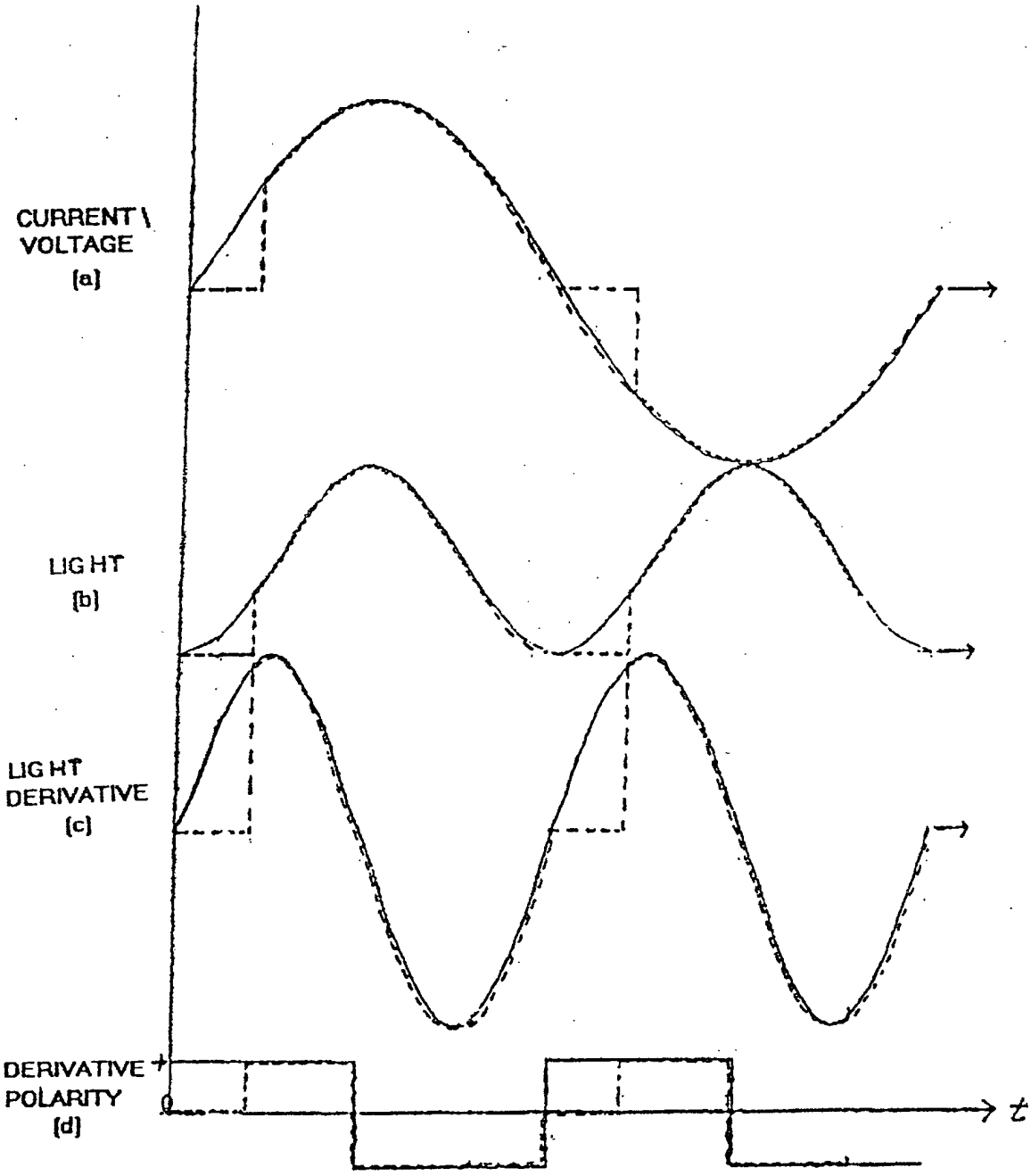
CURRENT \
VOLTAGE
(a)
LIGHT
(b)
LIGHT
DERIVATIVE
(c)
DERIVATIVE +
POLARITY
(d)
0
t

FIG. 2

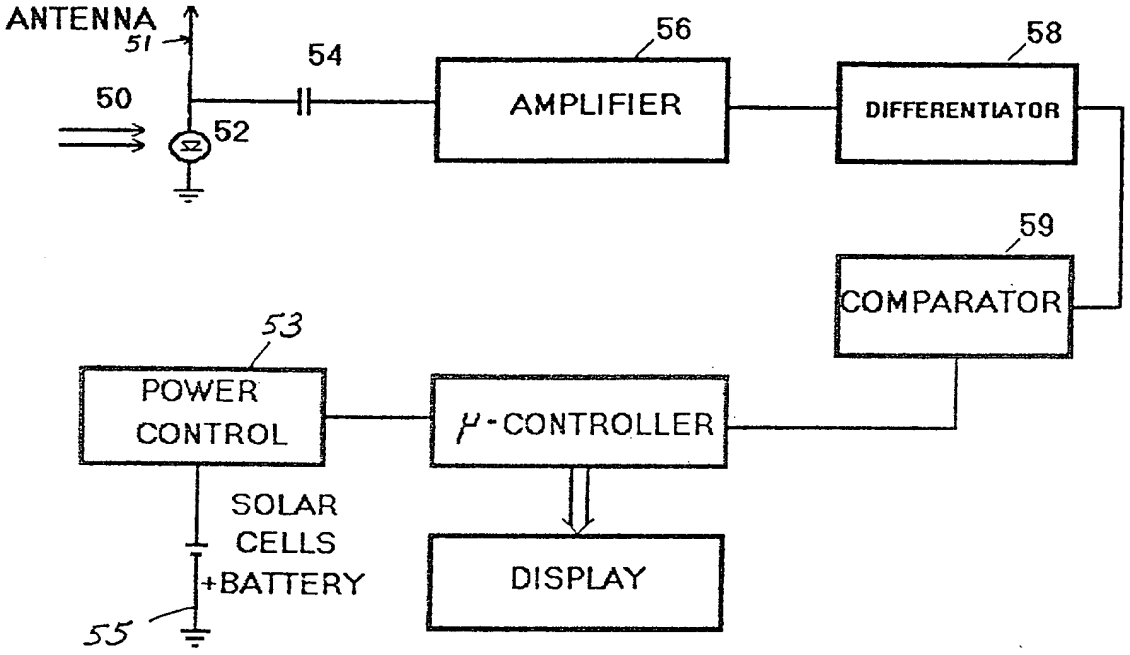
ANTENNA
51
50
52
54
56
AMPLIFIER
58
DIFFERENTIATOR
59
COMPARATOR
53
POWER CONTROL
μ-CONTROLLER
SOLAR CELLS +BATTERY
55
DISPLAY

FIGURE 4